TITLE

SYSTEM AND METHOD FOR FABRICATION BACKUP PLANNING

BACKGROUND

The present invention relates to a fabrication planning

5   system and particularly to a fabrication planning system for

scheduling fabrication backup operations in separately located

fabrication facilities.

Fig. 1 is a schematic view showing a conventional

fabrication system 100 containing Fabs 11 and 13, capable of

10   fabricating semiconductor wafers.   Fabs 11 and 13 are not

identical in tool composition, but have similar and/or partially

overlapping tool sets.   Fabs 11 and 13 contain tool groups

11a~11n and 13a~13n, respectively.   Tool groups 11a and 13a

comprise tools 111 and 131, respectively. Tools in tool groups

15   11a~11n and 13a~13n are controlled by Manufacturing Execution

Systems (MESs) 110 and 130, respectively.   Although both Fabs

11 and 13 belong to fabrication system 100, they are not only

geographically separated but also operate independently.

Because of the independent operation, workloads allocated to Fab

11 cannot be processed in Fab 13, and vice versa. Even though

Fab 13 is available as a backup, workload in Fab 11 remains idle

when tool bottleneck occurs. Thus, some tools in Fab 13 may

remain idle despite Fab 11 having wafer lots queued at a

5   corresponding tool. The independent operation of Fabs 11 and

13 actually hinders the fabrication system 100 from optimum

utilization.

While cross-Fab backup within a fabrication system is

clearly desired, it is not routinely practiced due to great

10   difficulty in coordinating capacity of independent fabrication

facilities. Cross-Fab backup is presently planned and executed

manually in the conventional fabrication system, which is an

inefficient and mistake-prone process. Conventionally,

planning for backup operation starts only when a tool bottleneck

15   occurs. At the beginning of the backup planning stage, the

backup demand of the bottlenecked tool is calculated according

to WIP profile and capacity of the bottlenecked tool. After the

backup demand is determined, it is then determined whether a

backup operation will be executed. Considerable communication

20   is required when querying other Fabs for capable of providing

backup support to the bottlenecked tool. Moreover, because backup planning starts only when a tool bottleneck occurs, latent tool bottlenecks are concealed. As a result, the backup operation cannot be arranged in advance, and the throughput of

5   the Fab will be seriously hindered by the bottleneck.

Hence, there is a need for a fabrication system that addresses inefficient backup planning arising from the existing technology.

SUMMARY

10   It is therefore an object of the invention to provide a system and method for backup planning to enhance the overall utilization and throughput of a fabrication system. To achieve this and other objects, the present invention provides a system and method of identifying latent tool bottlenecks in advance.

15   According to the invention, a backup planning device is provided within a fabrication system. The fabrication system contains a plurality of separately located fabrication facilities, each of which comprises a plurality of tool groups, wherein each tool group comprises a plurality of tools.

3

The backup planning device schedules backup operations between the fabrication facilities by introducing a virtual tool into each of the tool groups. The capacity of the virtual tool is combined into first capacity information of the tool group

5 to generate second capacity information thereof accordingly. The first capacity information comprises capacity information of effective tools in the respective tool group, while the second capacity information comprises capacity information of effective tools plus the virtual tool. A first manufacturing

10 plan for the tool group is determined according to a master production schedule (MPS), a work-in-process (WIP) profile, and the second capacity information thereof. A second manufacturing plan is determined according to the workload allocation of the virtual tool in the first manufacturing plan.

15 The invention also provides a backup planning method for scheduling backup operations in the separately located fabrication facilities within the fabrication system mentioned above. First, first capacity information, a master production schedule, and a WIP profile of the tool group are provided.

20 Second, a virtual tool is assigned to each of the tool groups.

4

Then capacity of the virtual tool is combined into the first

capacity information of the tool group to generate second

capacity information thereof accordingly. Next, a first

manufacturing plan for the tool group is determined according

5   to the master production schedule, the WIP profile. Then, a

second manufacturing plan is determined according to the

workload allocation for the virtual tool in the first

manufacturing plan.

The above-mentioned method may take the form of program

10   code embodied in a computer readable tangible media. When the

program code is loaded into and executed by a machine, the

machine becomes an apparatus for practicing the invention.

A detailed description is given in the following

embodiments with reference to the accompanying drawings.

15   **BRIEF DESCRIPTION OF THE DRAWINGS**

The present invention can be more fully understood by

reading the subsequent detailed description and examples with

references made to the accompanying drawings, wherein:

5

Fig. 1 is a schematic view of a conventional fabrication system;

Fig. 2 is a schematic view of a fabrication system according to the present invention;

5   Fig. 3 is a flowchart of the backup planning method of the system in Fig. 2;

Figs. 4A to 4E illustrate manufacturing plans for a tool group in accordance with the present invention; and

Fig. 5 is a diagram of a storage medium storing a computer

10   program providing the backup planning method of the present invention.

DETAILED DESCRIPTION

The present invention will now be described with reference to Figs. 2 to 5, which in general relate to a backup planning

15   device within a fabrication system. While the preferred embodiment of the invention operates with semiconductor fabrication systems, it is understood that the type of article processed by the fabrication system is not critical to the present invention, and any fabrication system having

fabrication facilities with overlapped tool sets may employ the present invention.

Fig. 2 is a schematic view of a fabrication system according to the present invention. The fabrication system 200 is a

5   semiconductor fabrication system, and contains Fabs 21 and 23 and a backup planning device 25.

Each Fab comprises a plurality of tool groups, each of which comprises a plurality of tools for performing various wafer fabrication functions. In addition, each Fab comprises a

10   manufacturing execution system (MES) for controlling the tools thereof. Fab 21, for example, contains MES 210 and tool groups 21a to 21n, wherein the tool group 21a comprises tools 211 and 212 for performing photolithography functions. Fab 23 contains MES 230 and tool groups 23a to 23n, wherein the tool group 23a

15   comprises tools 231 and 232 for performing photolithography functions.

Backup planning device 25, coupled with MES 210 and MES 230 through a network 27, schedules backup operations between Fabs 21 and 23 by introducing a virtual tool into each of the tool

20   groups. For example, virtual tools 22 and 24 are introduced to

7

tool groups 21a and 23a, respectively. Database 29 stores actual

capacity information of Fabs 21 and 23, wherein the actual

capacity information specifies the effective capacity of tools

211, 212, 231, and 232, respectively. The capacity of the

5   virtual tool for tool groups 21a and 23a to generate assumed

capacity information of tool groups 21a and 23a, respectively.

Assumed manufacturing plans for tool groups 21a and 23a are

determined according to master production schedules, WIP

profiles, and assumed capacity information thereof

10   respectively. Proposed manufacturing plans for tool group 21a

and 23a are determined according to the workload allocation for

virtual tools 22 and 24 in the assumed manufacturing plans

respectively.

The invention also provides a backup planning method for

15   scheduling backup operations in the separately located

fabrication facilities within the fabrication system mentioned

above. Fig. 3 is a flowchart of the backup planning method of

the system in Fig. 2.

First, actual capacity information, a master production

20   schedule, and a WIP profile for tool group 21a are provided (step

S31). The actual capacity information of tool group 21a

comprises capacity information of tools 211 and 212, which are

effective and assumed to have equal capacity.

Second, virtual tool 22 is assigned to tool group 21a (step

5 S32). Virtual tool 22 has unlimited capacity and is the least

preferred tool in tool group 21a.

The capacity of virtual tool 22 is then combined into the

actual capacity information of tool group 21a to generate

assumed capacity information thereof accordingly (step S33).

10 Next, an assumed manufacturing plan for tool group 21a is

determined according to the master production schedule, the

assumed capacity information, and the WIP profile thereof (step

S34).

Then, it is determined whether virtual tool 22 has

15 allocated workload (step S35), and if so, tool group 21a is

classified as a backup request tool group and the method proceeds

to step S36, otherwise the procedure of the method is complete.

Tool group 21a has a backup demand equal to the allocated

workload of virtual tool 22.

In step S36, an assumed manufacturing plan for tool group 23a is retrieved, wherein tool groups 21a and 23a have overlapping tool sets as mentioned above.

Then, the assumed manufacturing plan for tool group 23a is checked to determine whether tool 231 or 232 is available to provide backup support for tool group 21a (step S37).

When tool 231 or 232 is available to backup tool group 21a, proposed manufacturing plans for tool groups 21a and 23a are determined according to the assumed manufacturing plans thereof (step S38).

In order to correctly represent the request and supply of backup operation in the manufacturing plans for tool groups 21a and 23a, the planned backup operation is incorporated into the manufacturing plans to generate confirmed manufacturing plans for tool groups 21a and 23a respectively (step S39). To represent the backup capacity received from tool group 23a, a simulated backup tool is added to tool group 21a, wherein the simulated backup tool has capacity equaling backup capacity received from tool group 23a. To represent the capacity offered

for backup operation, tools 231 and 232 are allocated an equal

share of workload gained in the backup operation.

Additionally, to illustrate how the backup planning is

achieved by incorporating virtual tools into the manufacturing

5   scheduling, actual and assumed manufacturing plans for tool

group 21a are shown in Figs. 4A to 4E. Fig. 4A shows an actual

manufacturing plan for tool group 21a before introducing virtual

tool 22 thereto. The actual manufacturing plan is determined

according to actual capacity information, master production

10   schedule, and WIP profile of tool group 21a. As shown in the

bar chart of Fig. 4A, on days 1 and 4, workload consumes capacity

of one tool; on days 2 and 3, workload consumes capacity of two

tools. As mentioned above, tool group 21a comprises two

effective tools 211 and 212, thus the workload on days 2 and 3

15   exhausts the capacity of tool group 21a.   The actual

manufacturing plan shows allocated workload on each workday but

not workload in excess of the effective capacity of tool group

21a.   The queued workload is hidden from view in the

manufacturing plan before introducing the virtual tool into tool

20   group 21a. When virtual tool 22 is introduced into tool group

11

21a, tool group 21a has an assumed manufacturing plan as shown

in Fig. 4B, wherein the shaded parts in the bar chart represent

workload allocated to virtual tool 22. Because virtual tool 22

has unlimited capacity and is the least preferred tool in tool

5   group 21a, the queued workload can be represented as workload

allocated to virtual tool 22. Therefore, when workload is

allocated to virtual tool 22, tool group 21a requires backup.

Tool group 21a has a backup demand equal to the allocated

workload of virtual tool 22.

10   According to this embodiment, tool group 23a located in Fab

23 is the only possible source of backup support for tool group

21a, and tool group 23a has an assumed manufacturing plan

produced according to the aforementioned method. Then, the

assumed manufacturing plan for tool group 23a is checked to

15   determine whether tool 231 or 232 is available to provide backup

support for tool group 21a. Fig. 4C shows the assumed

manufacturing plan for tool group 23a. As shown in the bar chart

in Fig. 4C, on days 1 and 4, workload consumes capacity of one

and two tools respectively, and virtual tool 24 has no allocated

20   workload. Therefore, tool group 23a does not require backup

support and can provide backup support on days 1, 2, and 3. When

tool group 23a is available to backup tool group 21a, proposed

manufacturing plans for tool groups 21a and 23a are determined

according to the assumed manufacturing plans thereof. The

5   proposed manufacturing plan specifies that queued workload of

tool group 21a on days 2 and 3 is transferred to tool group 23a,

processed there, and sent back to tool group 21a after the backup

operation is complete.

The proposed manufacturing plan, however, does not

10   represent the request and supply of backup between tool groups

21a and 23a, thus the workload of tool groups 21a and 23a maybe

incorrectly estimated. In order to correctly represent the

request and supply of backup in the manufacturing plans for tool

groups 21a and 23a, the planned backup operation is incorporated

15   into the manufacturing plans to generate confirmed

manufacturing plans for tool groups 21a and 23a respectively.

To represent the backup capacity received from tool group 23a,

a simulated backup tool is added to tool group 21a, wherein the

simulated backup tool has capacity equaling backup capacity

20   received from tool group 23a. The confirmed manufacturing plan

13

for tool group 21a is shown in Fig. 4D, wherein the shaded part

in the bar chart represents workload allocated to the simulated

backup tool. To represent the capacity available for backup,

tools 231 and 232 are allocated an equal share of workload gained

5   in the backup operation. The confirmed manufacturing plan for

tool group 23a is shown in Fig. 4E, wherein the shaded part in

the bar chart represents workload obtained from tool group 21a.

The backup planning method implemented in the backup

control system of the present invention, or certain aspects or

10   portions thereof, may take the form of program code (i.e.

instructions) embodied in a tangible media, such as floppy

diskettes, CD-ROMS, hard drives, or any other machine-readable

storage medium, wherein, when the program code is loaded into

and executed by a machine, such as a computer, the machine

15   becomes an apparatus for practicing the invention. The methods

and apparatus of the present invention may also be embodied in

the form of program code transmitted over some transmission

medium, such as electrical wiring or cabling, through fiber

optics, or via any other form of transmission, wherein, when the

20   program code is received and loaded into and executed by a

14

machine, such as a computer, the machine becomes an apparatus

for practicing the invention. When implemented on a

general-purpose processor, the program code combines with the

processor to provide a unique apparatus that operates

5   analogously to specific logic circuits.

Fig. 5 is a schematic diagram of a storage medium for a

computer program providing the backup planning method according

to the present invention. The computer program product includes

a storage medium 510 having computer readable program code

10   embodied in the medium for use in a computer system 500, the

computer readable program code comprising at least computer

readable program code 511 receiving first capacity information,

a master production schedule, and a WIP profile of the tool

group, computer readable program code 512 assigning a virtual

15   tool to each of the tool groups, computer readable program code

513 combining capacity of the virtual tool into the first

capacity information of the tool group to generate a second

capacity information thereof accordingly, and computer readable

program code 514 determining a first manufacturing plan for the

tool group according to the master production schedule, the WIP

profile, and the second capacity information thereof.

While the invention has been described by way of example

and in terms of the preferred embodiments, it is to be understood

5   that the invention is not limited to the disclosed embodiments.

To the contrary, it is intended to cover various modifications

and similar arrangements (as would be apparent to those skilled

in the art). Therefore, the scope of the appended claims should

be accorded the broadest interpretation so as to encompass all

10   such modifications and similar arrangements.